R-E-M-A-R-K-S

The number of claims that remain in this application is 30.

The Applicant respectfully thanks the Examiner for his careful examination and allowance of the subject matter of claims 6-8, 12-14, 16, 17, 19-27 and 29-30.

The only amendment to the claims consists in correcting the preamble of claim 28 to comply with the Examiner's objection as detailed herein.

Claim Objection

The Examiner objects to Claim 28 as its preamble is believed to be grammatically incorrect.

Accordingly, the Applicant has amended "A method of deriving a model use in a pattern matching method in accordance with claim 1, the method comprising steps of:" to read – A method of deriving a model used in a pattern matching method in accordance with claim 1, the method comprising steps of:–.

The Applicant believes that this objection is now overcome.

Rejection under 35 U.S.C. 102(b) in view of Tsai

The Examiner rejects Claims 1-5, 9, 18 and 28 under 35 U.S.C. 102(b) as being anticipated by the article "Robust Affine Invariant Matching with Application to Line Features" by Tsai.

The Applicant courteously disagrees. The claimed invention differs from Tsai in many aspects, some of which are discussed below.

With regard to Claim 1, the Examiner states that Tsai discloses a method "using a model defined by a set of one or more model primitives representative of large scale structures of an archetype". This is incorrect.

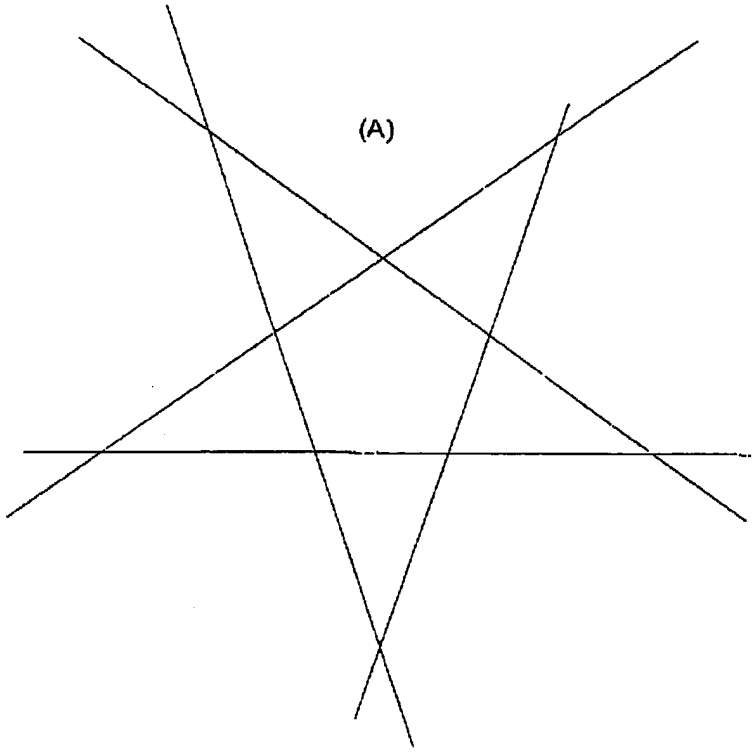
Tsai discloses an object recognition method based on **lines**, as disclosed on page 393, right column, first paragraph. The lines are obtained by detecting edge points and extracting lines from the edge points using the Hough transform.

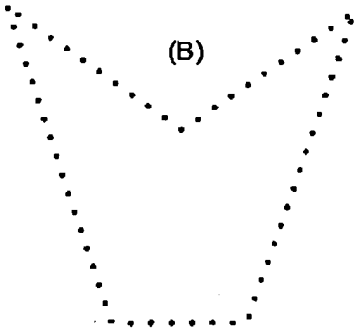
The Applicant courteously points out that the lines are of **infinite length**. (Each line is represented by a parameter pair (θ,r), as disclosed on page 394, section 2, first paragraph.)

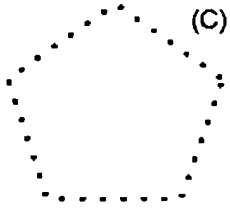
In a model represented by a set of lines, a line is only evidence that a certain number of edge points belong to this line; a line provides no information as to **where**, along this infinite length line, these edge points are situated. Therefore, the lines in Tsai cannot be model primitives that represent large scale structures of an archetype.

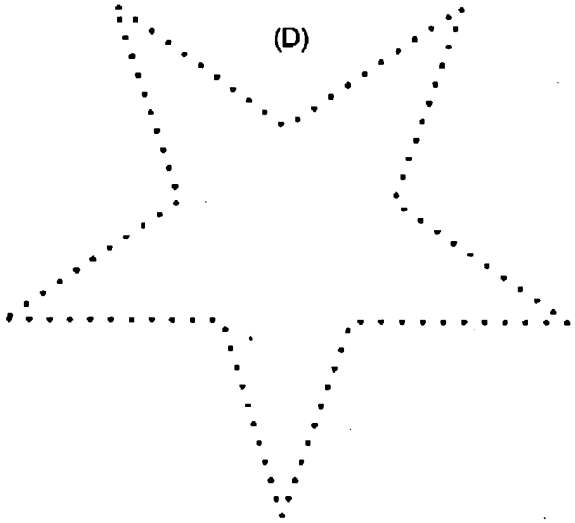
The figures below help illustrate the arguments above.

Application Number 09/978,000
Amendment dated January 6, 2005
Reply to Office action of October 6, 2004









According to the edge points, the objects in (B), (C), and (D) have different large scale structures. However, the same set of lines (A) is extracted in each case. Therefore, as stated earlier, lines are not representative of large scale structures of an object.

The Examiner further states that Tsai discloses the step of "deriving at least one target primitive representative of a large scale structure of the image". This is also incorrect. Similar arguments as above apply here. The lines of Tsai are not target primitives representative of large scale structures of the image.

The Applicant therefore believes that claim 1 is patentable in view of Tsai. The Applicant further believes that claims 2-27 are patentable in view of Tsai as they are dependent from a claim which is believed to be patentable in view of Tsai.

As for Claim 28, arguments similar to those provided above are applicable thereto since it comprises limitations which are similar to those of Claim 1.

With regard to Claim 28, the Applicant further believes that, contrary to the Examiner's statement, Tsai does not disclose the steps of: "sampling each model primitive at two or more respective sample locations; mapping each sample location to a respective sample bin of a hash table; and inserting a reference to the respective model primitive in the sample bin."

The method of deriving a model according to Tsai is described on page 395, right column, subsection 5.1. First, lines are detected. Then, for every feasible basis consisting of 3 lines, the following steps are performed:

for each remaining line (θ, r),

- the affine invariant (θ', r') of the line in terms of the basis is computed,

- the computed invariant (θ', r') is used to index a 2D hash table entry, and
- a "node" (M, b, l, inv, cov) is recorded in the indexed hash table entry.

In Tsai, each line represented in terms of a basis is mapped to a **single** hash table entry and a corresponding "node" is recorded in this **single** hash table entry. Thus, Tsai does not disclose the aforementioned steps of "sampling each model primitive at two or more respective sample locations; mapping each sample location to a respective sample bin of a hash table; and inserting a reference to the respective model primitive in the sample bin."

Furthermore, the Examiner cites p. 395, section 4 as evidence of the step of "sampling each model primitive at two or more respective sample locations". The Applicant courteously disagrees; the Applicant finds no evidence of the sampling step in the cited section.

The Applicant therefore believes that claim 28 is patentable in view of Tsai.

In view of the foregoing arguments, the Applicant believes that the rejection in view of Tsai is now overcome.

Rejection under 35 U.S.C. 102(b) in view of Baek *et al.*

The Examiner has rejected claims 1 and 28 under 35 U.S.C. 102(b) as being anticipated by the article "Occluded object recognition using extended local features and hashing" by Baek *et al.*

The Applicant courteously disagrees. The claimed invention differs from Baek *et al.* in many aspects, some of which are discussed below.

With regard to Claim 1, the Examiner states that Baek *et al.* disclose the step of "for each target primitive: identifying any model primitives that at least partially match the target primitive". This is incorrect.

In Baek *et al.*, an image feature is matched to a model feature using a hashing scheme. During the modeling phase, a model feature is converted into a unique key. Then, a hashing function transforms this key into an address in memory, where the model feature record is then stored. During the hypothesis generation phase, an image feature is converted into a key, and this key is transformed into an address in memory, using the same conversion scheme and hashing function as during the modeling phase. If this address contains a model feature record, the record is retrieved.

For an image feature to be matched to a model feature, the image feature must be converted into exactly the same key as the model feature was.

The conversion of a feature into a 7-digit key is described on page 2369, right column, third and fourth paragraphs. A feature is converted into a 7-digit key by quantizing parameters of the feature so they can be represented using an assigned number of digits. More specifically, the range of each parameter is divided into equal quantization units and a unique digit code is assigned to each quantization unit.

For an image feature to have the **same key** as a model feature, **each parameter** of the image feature must fall within the same quantization unit as the corresponding parameter of the model feature.

However, the key is derived from global parameters of the feature, such that if a portion of the feature is **missing**, the global parameters can change, resulting in a **different key**. For example, for a corner, the key is obtained by quantizing the angle between and the lengths of the two straight lines creating

the corner. If a portion of the first straight line is missing, the 2 digits representing the length of the first straight line change, resulting in a different key.

In Baek *et al.*, for an image feature, only a model feature that matches the image feature so closely that **all** the parameters of the image feature fall in the same quantization units as those of the model feature is identified.

The Applicant therefore submits that the limitation "for each target primitive: identifying any model primitives that **at least partially** match the target primitive" (emphasis added) is neither disclosed nor suggested by Baek *et al.* in the section cited by the Examiner (page 2370, left column, subsection "B. Matching") or anywhere else therein.

The Applicant therefore believes that claim 1 is neither disclosed nor suggested by Baek *et al.*

As for Claim 28, arguments similar to those provided above are applicable thereto since it comprises limitations which are similar to those of Claim 1.

With regard to Claim 28, the Applicant further believes that, contrary to the Examiner's statement, Baek *et al.* do not disclose the steps of: "sampling each model primitive at two or more respective sample locations; mapping each sample location to a respective sample bin of a hash table; and inserting a reference to the respective model primitive in the sample bin."

The method of deriving a model according to Baek *et al.* is described on p. 2369, section III, subsection A. First, extended local features are extracted from an image with a model object. Then, for each extended local feature, the local feature is mapped to an address in memory and the local feature record is stored at this address. (The local feature is mapped to an address in memory as described previously; namely, the local feature is converted into a key, and a hashing function transforms this key into an address in memory.)

In Baek *et al.*, each local feature is mapped to a **single** address in memory and a local feature record is stored at this **single** address. Thus, Baek *et al.* do not disclose the aforementioned steps of: "sampling each model primitive at two or more respective sample locations; mapping each sample location to a respective sample bin of a hash table; and inserting a reference to the respective model primitive in the sample bin."

Furthermore, the Examiner cites p. 2369, right column, third paragraph as evidence of the step of "sampling each model primitive at two or more respective sample locations". The Applicant courteously disagrees. As described above, this paragraph explains how a local feature is converted into a 7-digit key by quantizing parameters of the feature; it provides no evidence of the aforementioned sampling step.

The Applicant therefore believes that claim 28 is patentable in view of Baek *et al.*

In view of the foregoing arguments, the Applicant believes that the rejection in view of Baek *et al.* is now overcome.

Rejection under 35 U.S.C. 102(b) in view of Procter *et al.*

The Examiner has rejected claims 1-5, 9-11, 15, 18 and 28 under 35 U.S.C. 102(b) as being anticipated by the article "ForeSight: Fast Object Recognition Using Geometric Hashing with Edge-Triple Features" by Procter *et al.*

The Applicant courteously disagrees. The claimed invention differs from Procter *et al.* in many aspects, some of which are discussed below.

With regard to Claim 1, the Examiner states that Procter *et al.* disclose the step of "for each identified model primitive, calculating a figure of merit indicative

of a degree of correspondence between the target primitive and the model primitive". This is incorrect.

The Examiner cites the paragraph under Fig. 1 on p. 890, stating that the "peaks" are the figure of merit. The Applicant believes that the peaks are not a figure of merit indicative of a degree of correspondence between the target primitive and the model primitive.

In Procter *et al.*, in the model preprocessing stage, for every visible edge-triple ABCD in each view, an entry (*model, viewpoint, triple ID*) is added to the hash table bin indexed by (α, β), as disclosed on p. 890, right column, first paragraph. At recognition time, edge-triples are extracted from the input image and used to index the hash table, and votes are accumulated for (*model, viewpoint*) pairs, as disclosed on p. 890, first paragraph under Fig. 1. More precisely, at recognition time, for each edge-triple ABCD extracted from the input image, the hash table bin indexed by (α, β) is accessed; therefore, if there are n_t edge-triples in the input image, this results in n_t accesses to the hash table, as pointed out on p. 891, section 4.2, first paragraph.

If the indexed hash bin contains an entry (*model, viewpoint, triple ID*), a vote is cast for the (*model, viewpoint*) pair. Procter *et al.* do not perform a step of calculating a figure of merit indicative of **a degree of correspondence** between the edge-triple extracted from the input image and the edge-triple extracted from an image of a model at a viewing angle.

There is no evidence that Procter *et al.* perform the step of "for each identified model primitive, calculating a figure of merit indicative of a degree of correspondence between the target primitive and the model primitive".

Now, a response is provided to the Examiner's statement that the "peaks" (disclosed on p. 890, first paragraph under Fig. 1) are the figure of merit. In Procter *et al.*, as edge-triples are processed, votes are accumulated for (*model,*

viewpoint) pairs. The "vote array" contains the accumulation of votes for every (*model, viewpoint*) pair. Once all edge-triples have been processed, peaks in the vote array are analyzed. A peak in the vote array corresponds to an **accumulation** of votes for a particular (*model, viewpoint*) pair. A peak is therefore not a figure of merit indicative of a degree of correspondence between a target primitive and a model primitive as claimed in claim 1.

The Applicant therefore believes that claim 1 is neither suggested nor taught in view of Procter *et al.*

The Applicant further believes that claims 2-27 are neither suggested nor taught in view of Procter *et al.* as they are dependent from a claim which is believed to be neither suggested nor taught in view of Procter *et al.*

As for Claim 28, arguments similar to those provided above are applicable thereto since it comprises limitations which are similar to those of Claim 1.

With regard to Claim 28, the Applicant further believes that, contrary to the Examiner's statement, Procter *et al.* do not disclose the steps of: "sampling each model primitive at two or more respective sample locations; mapping each sample location to a respective sample bin of a hash table; and inserting a reference to the respective model primitive in the sample bin."

The method of deriving a model according to Procter *et al.* is described on p. 890, right column, first paragraph: "For every visible edge-triple ABCD in each of these views, an entry (*model, viewpoint, triple ID*) is added to the hash table bin indexed by (α, β), where α is the projection of scene angle $\angle ABC$ onto the image plane, and β is the projection of $\angle BCD$."

In Procter *et al.*, an edge-triple is mapped to a **single** hash table bin and an entry is added to this **single** hash table bin. In response to the Examiner's statement that "sampling is provided by two projections for each edge-triple", the

Applicant points out that the parameters α and β of the edge-triple are used to index a single bin in a 2D hash table. Thus, Procter *et al.* do not disclose the aforementioned steps of: "sampling each model primitive at two or more respective sample locations; mapping each sample location to a respective sample bin of a hash table; and inserting a reference to the respective model primitive in the sample bin."

The Applicant therefore believes that claim 28 is patentable in view of Procter *et al.*

In view of the foregoing arguments, the Applicant believes that the rejection in view of Procter *et al.* is now overcome.

In view of the foregoing, reconsideration of the rejection of claims 1-5, 9-11, 15, 18, 28 is respectfully requested. It is believed that claims 1-30 presented herein are allowable over the prior art and a Notice of Allowance is earnestly solicited.

Respectfully submitted,
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Name of person signing certification

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January 6, 2004
Date